LNG Demand-Supply and Trends in Natural Gas in the Asia-Pacific Region*

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The Asia-Pacific LNG market was formed in 1969, when Japan started to import LNG from Alaska. Since then, this market has grown by leaps and bounds in terms of both quantity and geography, riding on the winds of Japan's energy diversification policy based on the lessons from the two oil crises in the 1970s, introduction of anti-air pollution measures, and expansion of energy demand driven by rapid economic growth. The LNG trading volume in the Asia-Pacific market expanded from 0.18 MT (million tonnes) in FY1969 to 77.87 MT in 2002. Following Japan, South Korea started to import LNG in 1986, Taiwan in 1990, and then India in January 2004. The number of LNG exporting countries has also increased. In the 1970s, Brunei, Indonesia, and Abu Dhabi joined the regional LNG market as new LNG exporters, followed by Malaysia and Australia in the 1980s, and then by Qatar and Oman in 1990s and after.

As will be explained later, LNG demand is expected to continue increasing in the Asia-Pacific market. In addition, China will become another LNG importer in 2005. Moreover, there are many plans for constructing LNG receiving terminals on the West Coast of the United States and Mexico that will also be new importer of the region. On the supply side, Russia will enter the LNG market in 2007 when Sakhalin 2 starts LNG production. There are also plans to construct LNG production facilities in South America targeting mainly the North American market. Furthermore, existing exporters also have many plans for new projects as well as expansion projects of their existing plants. Those projects may increase LNG supply capacity for the Asia-Pacific market to a significant extent. Currently, the supply growth is said to exceed that of demand, and this oversupply situation is likely to continue in the short to medium term.

North East Asia depends on LNG for its natural gas imports, and now Russian pipeline gas is emerging as a new option for the region. Sakhalin and East Siberia have huge gas reserves, and pipeline gas imports from these sources, if realized, would not only help diversify natural gas supply sources but also have influences on the Asia-Pacific LNG market.

The quantitative and geographical expansion and the oversupply situation in the Asia-Pacific LNG market are contributing to increasing market liquidity. So far, LNG suppliers in the Asia-Pacific region have exported most of their products to East Asia, and now they appear to be preparing to expand aggressively into Euro-American markets, where LNG demand is on the rapid increase. In Japan, the ongoing

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deregulation in the power and gas industries has deepened the uncertainty over prospective LNG demand. Therefore, it has become more important for LNG importers in Japan to reduce prices and to increase the flexibility of transactions. Reflecting these changes in the market, contracts signed recently often feature more flexible terms and conditions in line with importers' requirements and, especially after China's LNG contracts in 2002, lower price level.

This report intends to analyze and discuss the natural gas demand and supply trends in the Asia-Pacific region to which Japan belongs. What follows outlines the natural gas situation, and the LNG supply and demand trends in the region.

1. Natural Gas Demand and Supply

As of the beginning of 2003, the world's natural gas reserves stood at 180.6 Tcm (Trillion Cubic Meters), approximately 40% and 30% of which were respectively accounted for in the Middle East and the former Soviet Union. Meanwhile, the total for the Asia-Oceania region was 16.9 Tcm, accounting for less than 10% of the world's total. The world's natural gas production for the year 2002 was 2.60 Tcm, of which North America and the former Soviet Union each accounted for a little less than 30%, while the Asia-Oceania region accounted for 11%. As for consumption, North America and the former Soviet Union with high production volume, and Europe with well-developed pipeline networks for intra and inter-regional natural gas trade, occupied the top positions. The Asia-Oceania region consumed 327.1 Bcm (Billion Cubic Meters), accounting for 12.6% of the world's total consumption (Table 1 and Figure 1).

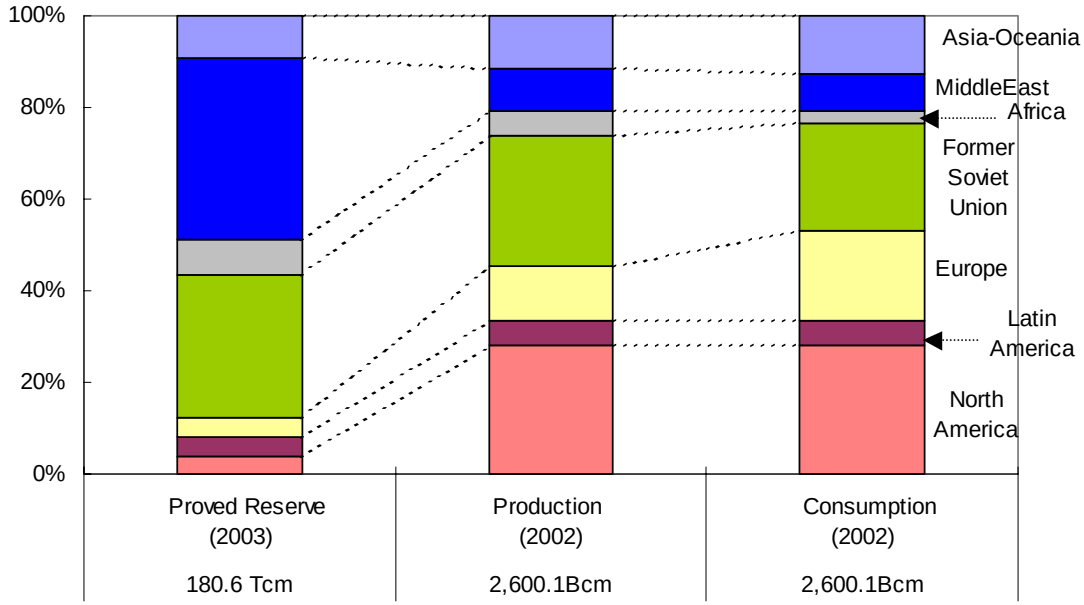
Table 1. World natural gas reserves, production and consumption

	Proved Reserve (2003)		Production (2002)		Consumption (2002)	
	Tcm	Share(%)	Bcm	Share(%)	Bcm	Share(%)
North America	7.0	3.9	727.2	28.0	725.2	27.9
Latin America	7.5	4.2	140.7	5.4	142.8	5.5
Europe	7.5	4.1	312.1	12.0	508.6	19.6
Former Soviet Unio	56.4	31.2	742.7	28.6	611.1	23.5
Africa	13.8	7.6	134.2	5.2	69.3	2.7
Middle East	71.5	39.6	245.6	9.4	216.1	8.3
Asia-Oceania	16.9	9.4	297.6	11.4	327.1	12.6
Total	180.6	100.0	2,600.1	100.0	2,600.1	100.0

Note: In Asia-Oceania, reserves and production include figures of 17 countries, namely Afghanistan, Australia, Bangladesh, Brunei, China, India, Indonesia, Japan, Malaysia, Myanmar, New Zealand, Pakistan, Papua New Guinea, Philippines, Taiwan, Thailand and Vietnam. Consumption figures include those 17 countries, Singapore and South Korea.

Source: Cedigaz, Natural Gas in the World

Figure 1. Share of world natural gas reserves, production and consumption by region



Source: Cedigaz, Natural Gas in the World

In the Asia-Oceania region, Australia and Indonesia accounted for 45.8% of the region's total reserves, followed by China and Malaysia for 15.4% and 14.6% respectively. As for production, Indonesia accounted

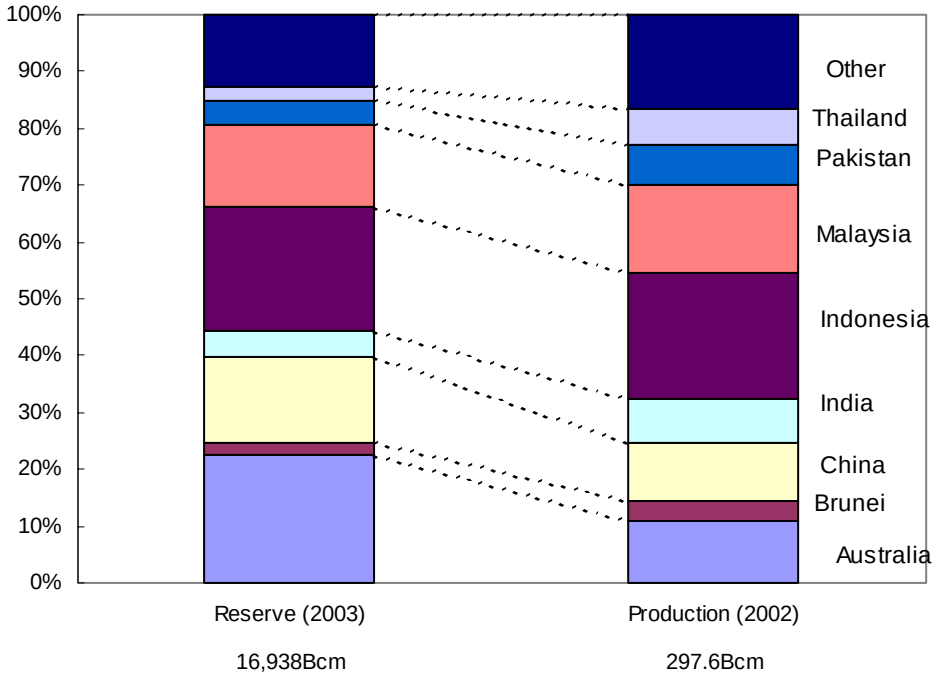
for 23.6% of the regional total, followed by Malaysia, Australia, and China accounting for 16.3%, 11.6% and 11.0% respectively. These countries, except China, export LNG or pipeline gas. As for consumption, Japan accounted for 23% of the regional total, followed by Indonesia for 10.4% and China for 10.0% which consume domestically produced gas, (Table 2, Figures 2 and 3).

Table 2. Natural gas reserves, production and consumption in the Asia-Pacific region

	Reserve (2003)		Production (2002)		Consumption (2002)	
	Bcm	Share(%)	Bcm	Share(%)	Bcm	Share(%)
Japan	40	0.2	2.6	0.9	75.3	23.0
South Korea	0	0.0	0.0	0.0	24.0	7.3
Taiwan	75	0.4	0.9	0.3	8.1	2.5
Afghanistan	100	0.6	0.1	0.0	0.1	0.0
Australia	3,930	23.2	34.6	11.6	24.6	7.5
Bangladesh	340	2.0	10.9	3.7	10.9	3.3
Brunei	350	2.1	10.9	3.6	1.7	0.5
China	2,600	15.4	32.6	11.0	32.6	10.0
India	790	4.7	25.0	8.4	25.0	7.6
Indonesia	3,825	22.6	70.4	23.6	33.9	10.4
Malaysia	2,478	14.6	48.5	16.3	28.0	8.6
Myanmar	445	2.6	8.4	2.8	2.2	0.7
New Zealand	65	0.4	6.2	2.1	6.2	1.9
Pakistan	750	4.4	22.9	7.7	22.9	7.0
Papua New Guinea	428	2.5	0.1	0.0	0.1	0.0
Philipines	107	0.6	2.0	0.7	2.0	0.6
Thailand	385	2.3	19.4	6.5	25.6	7.8
Vietnam	230	1.4	2.3	0.8	2.3	0.7
Singapore	0	0.0	0	0.0	1.8	0.5
Total	16,938	100.0	297.6	100.0	327.1	100.0

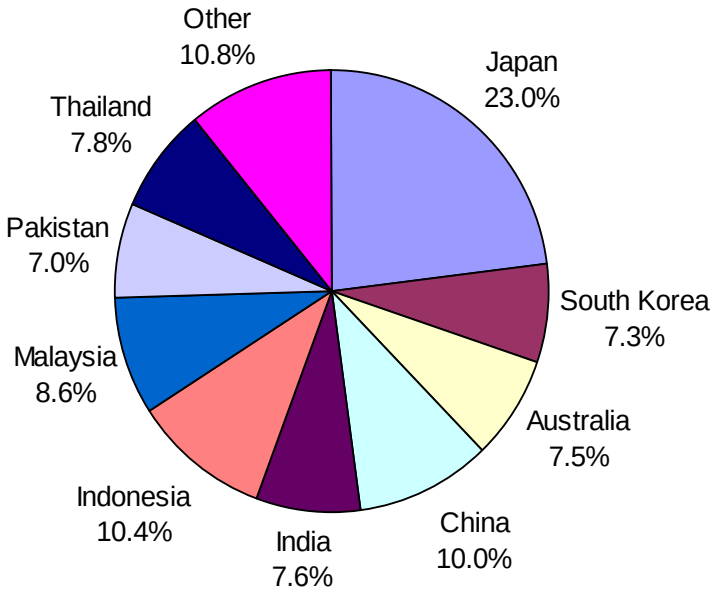
Source: Cedigaz, Natural Gas in the World

Figure 2. Share of natural gas reserves and production in the Asia-Pacific region



Source: Cedigaz, Natural Gas in the World

Figure 3. Share of natural gas consumption in the Asia-Pacific region



Source: Cedigaz, Natural Gas in the World

2. LNG Trade

(1) Overview

In 2002, the world's natural gas trade volume totaled 591.36 Bcm, 470.7 Bcm or 74.5% of the total was traded via pipelines. Meanwhile, the world's total LNG trade volume for 2002 was 150.66 Bcm, a 5.2% increase from the previous year. Asian importers (Japan, South Korea and Taiwan) still accounted for a dominant 69.1% of the world's LNG imports.

In 2002, Japan imported 72.8 Bcm of LNG (1.1% decrease from the previous year), accounting for 48.3% of the world's total. In the same year, South Korea's LNG imports turned upward after a temporary downturn due to the economic crisis (Table 3 and Figure 4).

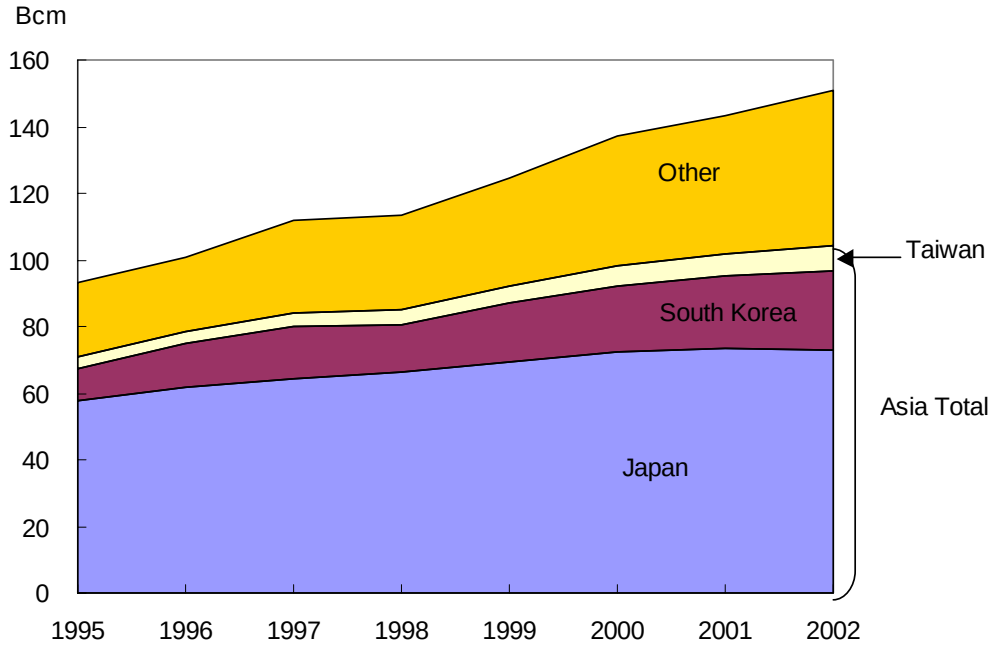
Reflecting the robust LNG demand in Europe and the US, new LNG projects in Trinidad and Tobago and Nigeria started commercial production in the 1990's targeting those markets. Surplus liquefaction capacities in the Middle East result in increasing LNG supply to Europe and the US.

Table 3. LNG imports by Asian countries (Japan, South Korea and Taiwan) 1995-2002

Importer	1995		1996		1997		1998		1999		2000		2001		2002	
	Bcm	%	Bcm	%	Bcm	%	Bcm	%	Bcm	%	Bcm	%	Bcm	%	Bcm	%
Japan	57.92	62.3	61.94	61.5	64.34	57.4	66.22	58.5	69.42	55.8	72.59	52.9	73.58	51.4	72.80	48.3
South Korea	9.53	10.3	12.95	12.9	15.7	14.0	14.31	12.6	17.52	14.1	19.68	14.4	21.83	15.2	24.06	16.0
Taiwan	3.32	3.6	3.53	3.5	4.13	3.7	4.65	4.1	5.35	4.3	5.98	4.4	6.40	4.5	7.20	4.8
Asia Total	70.77	76.2	78.42	77.9	84.18	75.1	85.18	75.2	92.29	74.2	98.25	71.7	101.81	71.1	104.06	69.1
World Total	92.93	100.0	100.73	100.0	112.12	100.0	113.2	100.0	124.4	100.0	137.10	100.0	143.27	100.0	150.66	100.0

Source: Cedigaz, Natural Gas in the World

Table 4. LNG imports by Asian countries (Japan, South Korea and Taiwan) 1995-2002



Source: Cedigaz, Natural Gas in the World

(2) Medium and Long Term Contracts

As of 2003, the total volume of medium- and long-term LNG contracts for Asia totaled 89.26 MT/year. The largest exporter in the region is Indonesia, whose total medium- and long-term contract volume with Japan, South Korea and Taiwan amounted to 26.9 MT/year in 2003, followed by Qatar and Malaysia with total contract volumes of 18.30 MT/year and 17.19 MT/year respectively.[1] As for new exporters, the Russian Sakhalin 2 Project concluded a contract with Japanese consumers under which they will start LNG transactions from 2007 or 2010. Meanwhile, the North American West Coast region will start to import 3.7 million tons/year of LNG from Indonesia in 2007 upon the first HOA (Heads of Agreement) concluded. Between 2009 and 2011, Australian and Indonesian contracts with Japanese consumers will come to an end; as a result, the total annual contract volume in the region will decrease from 109.04 MT/year for 2009 to 84.77 MT/year for 2012. Negotiations for extending these existing contracts and for concluding contracts for new projects are currently under way.

Table 4. Medium and long term LNG contracts in the Asia-Pacific region

(Million Tonnes)

Exporter	Importer	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Indonesia	Japan	18.18	18.18	15.63	15.63	15.63	15.63	15.63	15.63	6.22	2.70	2.70	2.70	0.40
	South Korea	5.30	5.30	6.35	6.35	6.35	4.05	4.05	4.05	4.05	4.05	4.05	4.05	2.05
	Taiwan	3.42	3.42	3.42	3.42	3.42	3.42	3.42	1.84	1.84	1.84	1.84	1.84	1.84
	China	0.00	0.00	0.00	0.00	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
	US	0.00	0.00	0.00	0.00	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70
	Sub-total	26.90	26.90	25.40	25.40	31.70	29.40	29.40	27.82	18.41	14.89	14.89	14.89	10.59
Malaysia	Japan	11.44	12.12	12.62	12.62	12.62	12.62	12.62	12.62	12.62	12.62	12.62	12.26	12.26
	South Korea	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	2.00	2.00	2.00	2.00	2.00
	Taiwan	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
	Sub-total	17.19	17.87	18.37	18.37	18.37	18.37	18.37	18.37	16.87	16.87	16.87	16.51	16.51
Brunei	Japan	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	0.00	0.00
	South Korea	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.00	0.00
	Sub-total	6.71	6.71	6.71	6.71	6.71	6.71	6.71	6.71	6.71	6.71	6.71	0.00	0.00
Australia	Japan	7.33	9.70	10.73	13.73	13.73	13.73	14.83	7.50	7.50	7.50	7.50	7.50	7.50
	South Korea	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00
	China	0.00	0.00	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
	Sub-total	7.83	10.20	14.53	17.53	17.53	17.53	18.63	11.30	10.80	10.80	10.80	10.80	10.80
US	Japan	1.23	1.23	1.23	1.23	1.23	1.23	1.23	0.00	0.00	0.00	0.00	0.00	0.00
UAE	Japan	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
	India	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
	Sub-total	4.78	4.78	4.78	4.78	4.78	4.78	4.78	4.78	4.78	4.78	4.78	4.78	4.78
Qatar	Japan	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
	South Korea	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80
	Taiwan	0.00	0.00	0.00	0.00	0.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	India	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
	Sub-total	18.30	18.30	18.30	18.30	18.30	21.30	21.30	21.30	21.30	21.30	21.30	21.30	21.30
Oman	Japan	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	South Korea	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06	4.06
	India	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
	Sub-total	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32
Russia	Japan	0.00	0.00	0.00	0.00	2.30	2.30	2.30	3.10	3.10	3.10	3.10	3.10	3.10
	Sub-total	0.00	0.00	0.00	0.00	2.30	2.30	2.30	3.10	3.10	3.10	3.10	3.10	3.10
Total		89.26	92.31	95.64	98.64	107.24	107.94	109.04	99.70	88.29	84.77	84.77	77.70	73.40

Note: 1. Figures in this table cover contract volume for SPA (Sale and Purchase Agreement) and HOA. Contract volume for MOU (Memorandum of Understanding) and LOI (Letter of Intent) are not included.
2. If there is a range in volume in a contract, lower figures are used. Option volume, if applied, is not included.
3. Figures in this table do not necessarily conform to those in actual delivery. Supply volume in early stage of project can be significantly less than contract volume. Factors such as gas demand level in importing countries and operating status of liquefaction plants also affect delivery volume.

Source: Press releases by importers and exporters and other industry sources

(3) Spot Transactions[2]

Most LNG transactions in the Asia-Pacific region are conducted on long-term contracts. The world's total spot transaction volume for 2002 accounted for only 7.8% of the world's total LNG transaction volume but has increased remarkably since the late 1990s (Figure 5). While long-term transactions are expected to remain mainstream, spot transactions could increase with expanded surplus liquefaction capacities and effective use of depreciated existing capacities.

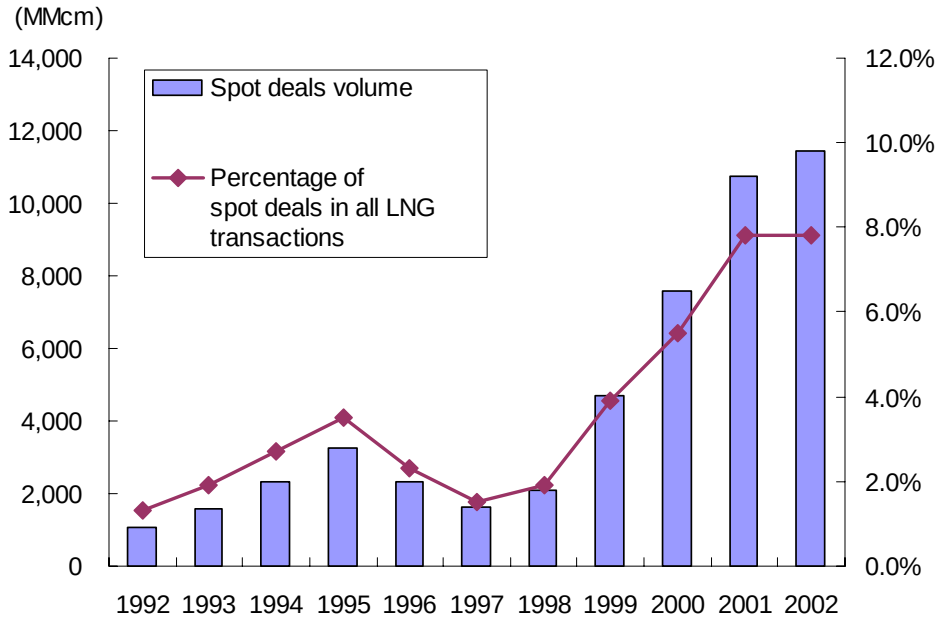
In the Asian market in 2002, Japan and South Korea imported LNG on spot basis (Table 5). It is thought that the shutdown of Indonesia's Arun liquefaction plants was the main cause of the rapid increase in Japan's spot LNG imports during the 2000−2001 period. Tohoku Electric Power announced that it procured a total

[1] Note that Qatar contract volume in 2003 includes a portion for India. However, the actual delivery did not take place in 2003.
[2] Here, the term refers to contracts with a period shorter than 1 year.

of 1.76 MT of LNG from Indonesia's Bontang (0.9 MT), Malaysia (0.34 MT), Qatar (0.4 MT), Oman, and Australia (0.6 MT each). While Japan depends on spot imports for 3% of its total LNG imports, South Korea's dependency on spot imports is much higher at 8.6% in order to cover the peak demand in winter.

One of the major impediments to spot transactions has been the lack of LNG vessel capacity. However, this impediment could gradually be reduced considering the robust LNG vessel orders in recent years.

Figure 5. World spot LNG deals (1992-2002)



Note: MMcm = 1 Million Cubic Meters

Source: Petrostrategies (July 28, 2003), BP Statistical Review of World Energy

Table 5. Spot deals by country

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Share of ex(im)porter in spot market in 2002
Exporter	Qatar						385	950	1,595	1,975	2,715	2,085	18.2%
	Algeria	525	485	585	350		600	450	1,330	1,375	2,360	2,665	23.3%
	Indonesia	225	235	375	525	600	280		380	1,180	1,915	150	1.3%
	Nigeria									370	1,290	530	4.6%
	Oman									600	825	2,275	19.9%
	Trinidad-Tobago								385	915	580	1,345	11.8%
	Malaysia	300	525	450	225	75			75	75	525	680	5.9%
	Abu Dhabi				1,425	1,390	75	340	650	635	315	1,205	10.5%
	Australia		340	575	665	265	300	375	300	450	225	300	2.6%
	Brunei			300	75							205	1.8%
	Libya			50									
Importer	US					225	300	525	1,660	3,725	3,235	3,420	29.9%
	Spain		265	940	1,050	980	985	825	1,685	1,430	2,290	4,155	36.3%
	South Korea	150	450	1,050	900	675		75	305	1,470	1,870	1,790	15.6%
	Japan	375	385	75	75	150	280		150	320	2,230	315	2.8%
	France				865	225			75	75	525	1,170	10.2%
	Italy	525	260	195				115	540	480	375	275	2.4%
	Belgium		225	75	150						150	265	2.3%
	Taiwan										75		
	Portugal									75			
	Puerto Rico											50	0.4%
	Turkey				225	75		575	300				
Spot deals volume		1,050	1,585	2,335	3,265	2,330	1,640	2,115	4,715	7,575	10,750	11,440	
Percentage of spot deals in all LNG transactions		**1.3%**	**1.9%**	**2.7%**	**3.5%**	**2.3%**	**1.5%**	**1.9%**	**3.9%**	**5.5%**	**7.8%**	**7.8%**	

Source: Petrostrategies (July 28, 2003), BP Statistical Review of World Energy

3. LNG facilities

(1) Liquefaction plants

There are LNG production facilities operating in 12 countries that are located in Africa (Algeria, Libya, and Nigeria), the Middle East (Abu Dhabi, Oman and Qatar), the Asia-Pacific region (Brunei, Indonesia, Malaysia and Australia), and North and Central America (the US and Trinidad and Tobago). As of 2003, the combined production capacity totaled 141.1 MT/year, 94.25 MT/year of the total was supposed to be mainly for the Asian market (Table 6).

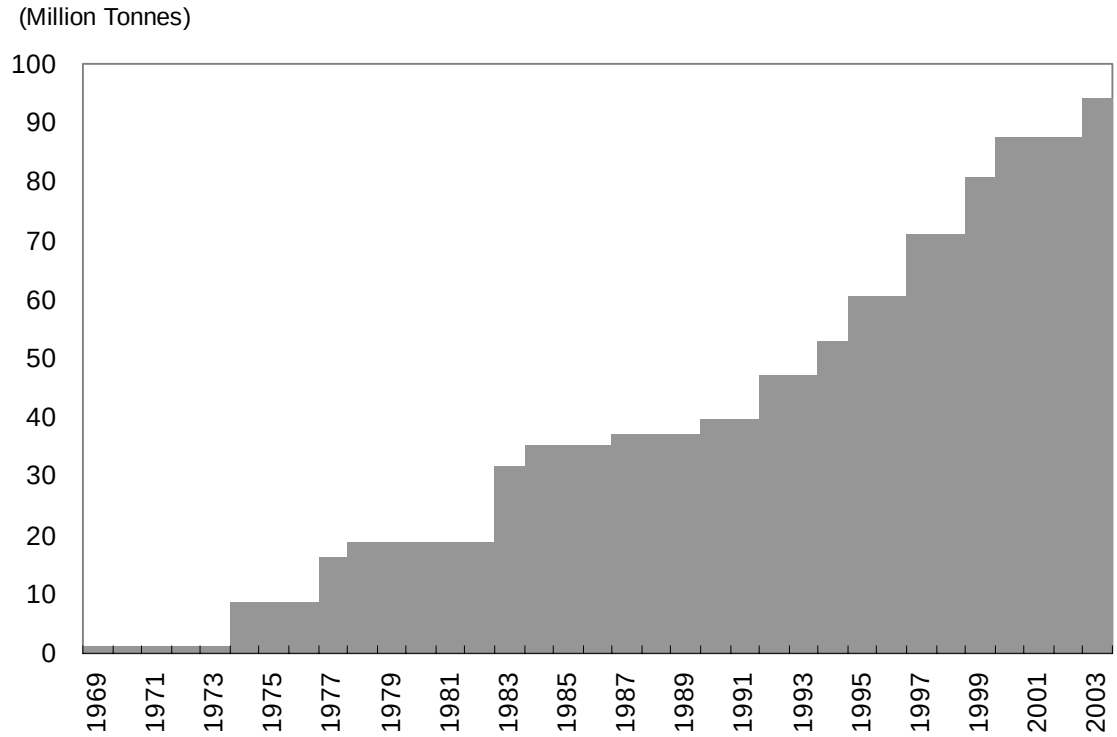
Table 6. Existing liquefaction plants in the Asia-Pacific and the Middle East as of 2003

	Country	Project (Train)	Liquefaction Capacity (Million Tonnes/Year)	Start-up	Investor	Main Destinations
Asia Pacific	Brunei	Brunei LNG (Train 1-5)	7.20	1972-1974	Brunei LNG (Brunei Government, Shell, Mitsubishi)	Japan, South Korea
	Indonesia	Bontang I (Train A, B)	5.20	1977	PT Badak NGL	Japan
		Bontang II (Train C, D)	5.20	1983		Japan
		Bontang III (Train E)	2.60	1990		Taiwan
		Bontang IV (Train F)	2.60	1994		Japan
		Bontang V (Train G)	2.70	1997		South Korea
		Bontang VI (Train H)	2.95	1999		Taiwan
		Arun I (Train 1)	2.60	1978	PT Arun NGL	Japan, South Korea
		Arun II (Train 4, 5)	3.40	1984		
		Arun III (Train 6)	1.90	1987		
	Malaysia	MLNG1: Satu (Train 1-3)	7.80	1983	Malaysia LNG (Petronas, Sarawak State Government)	Japn
		MLNG2: Dua (Train 4-6)	7.80	1995	Malaysia LNG Dua (Petronas, Shell, Mitsubishi, Sawarak State Government)	Japan, South Korea, Taiwan
		MLNG3: Tiga (Train 7, 8)	6.80	2003	Malaysia LNG Tiga (Petronas, Shell, Nippon Oil, Sarawak State Government., Mitsubishi)	Japan, South Korea
	Australia	NWS (Train 1-3)	7.50	1989-1992	Woodside Petroleum, Shell, ChevronTexaco, BHP Billiton, BP, Japan Australia LNG	Japan
	US	Kenai (Train 1, 2)	1.30	1969	ConocoPhilips, Marathon	Japan
	Sub-total		67.55			
Middle East	Abu Dhabi	ADGAS (Train 1, 2)	2.50	1977	ADGAS (ADNOC, Mitsui, BP, Total)	Japan, Spain
		ADGAS (Train 3)	3.00	1994		
	Oman	Oman LNG (Train 1, 2)	6.60	2000	Oman LNG (Oman Government, Shell, Total, Mitsubishi, Mitsui, Partex, Itochu, Korea LNG)	Japan, South Korea, Spain
	Qatar	Qatargas (Train 1-3)	8.00	1997	Qatargas (Qatar Petroleum, ExxonMobil, Total, Marubeni, Mitsui)	Japan,n Spain
		RasGas (Train 1, 2)	6.60	1999	Ras Laffan LNG Company Limited (Qatar Petroleum, ExxonMobil, KOGAS, Itochu, LNG Japan)	South Korea
	Sub-total		26.70			
Total			**94.25**			

Source: Industry Sources

In the Asia-Pacific region and the Middle East, Brunei and Indonesia were the first to construct liquefaction plants in the 1970s, followed by Malaysia and Australia in the 1980s, and then by Qatar and Oman in the 1990s and after. Thus, their combined liquefaction capacity has steadily increased (Figure 6).

Figure 6. Liquefaction capacity growth in the Asia-Pacific region and the Middle East 1969-2003



Source: Industry Sources

In addition to the existing capacity, there are many projects for constructing new plants or expanding existing capacities. In the Asia-Pacific region and the Middle East, LNG production capacities under construction and ones with SPAs or HOAs signed amount to 75.9 MT. It is likely that these capacities will be realized by around 2010 (Table 7).

Table 7. Liquefaction plants under construction and SPA/HOA signed in the Asia-Pacific region and the Middle East as of 2003

	Country	Project (Traind)	Liquefaction Capacity (Million Tonnes/Yea	Start-up	Investor	Destination
Asia Pacific	Australia	NWS (Train 4)	4.20	2004	Woodside, BHP Billiton, BP, ChevronTexaco, Shell, MIMI	Asia Pacific
		Darwin LNG	3.50	2005	ConocoPhillips, Woodside, Shell, Tokyo Electric, Tokyo Gas	Asia Pacific
	Indonesia	Tangguh (Train 1, 2)	6.00	2007	BP, MI Berau, Nippon Oil, CNOOC, KG Berau, LNG Japan	Asia Pacific
	Russia	Sakhalin 2 (Train 1, 2)	9.60	2007	Shell, Mitsui, Mitsubishi	Asia Pacific
	Sub-total		23.30			
Middle East	Oman	Oman LNG (Train 3)	3.30	2006	Oman Government, Oman LNG, Union Fenosa	Spain
	Qatar	Qatargas De-bottlenecking (Train 1-3)	1.20	2005	QP, ExxonMobil	Europe
		RasGas (Train 3)	4.70	2004	Ras Laffan LNG Company Limited II (QP, ExxonMobil)	India
		RasGas (Train 4)	4.70	2005	Ras Laffan LNG Company Limited II (QP, ExxonMobil)	Europe
		RasGas (Train 5, 6)	15.60	2008-9	Ras Laffan LNG Company Limited II (QP, ExxonMobil)	US East Coast
		Qatargas II (Train 1,2)	15.60	2007	QP, ExxonMobil	UK, Europe
		Qatargas III (Train 1)	7.50	2008-9	QP, ConocoPhillips	US East Coast
	Sub-total		52.60			
Total			75.90			

Source: Industry Sources

Moreover, there are also many projects undergoing feasibility studies. As shown in Table 8, liquefaction capacity in the Asia-Pacific and the Middle East can increase significantly in the future. However, the feasibility of these projects differs considerably depending on such uncertainties in LNG demand, political stability, environmental constraints and the strategies of each project developer. Therefore, not all of these projects will necessarily be realized, and even if they are, they may not become operational as start-up year indicated in the Table.

Table 8. Planned Liquefaction plants in the Asia-Pacific region and the Middle East as of 2003

	Country	Project (Train)	Liquefaction Capacity (Million Tonnes/Year)	Start-up	Investor	Destination
Asia Pacific	Australia	Greater Sunrise	4.00	2008	Woodside, ConocoPhillips, Shell, Osaka Gas	Asia Pacific
		NWS (Train 5)	4.20	2007	Woodside, BHP Billiton, BP, Chevron, Shell, MIMI	China, Asia Pacific
		Gorgon (Train 1, 2)	5.00	2008	ChevronTexaco, Shell, ExxonMobil	US West Coast, China
		Scott Reef	4.00	2015	Woodside, ChevronTexaco, BP, BHP Billiton, Shell	Asia Pacific
		Scarborough	4.00	2017	BHP Billiton, ExxonMobil	Asia Pacific
	Indonesia	Bongtang (Train I)	2.95	2004	Pertamina	Asia Pacific
		Bongtang (Train J)	3.00	2007	Pertamina	Asia Pacific
		Sulawesi	6.00	2007	Pertamina, Expan	Asia Pacific
		Natuna	15.00	N.A.	ExxonMobil, Pertamina	Asia Pacific
	Brunei	Brunei LNG Expansion	4.00	2008	Brunei LNG (Brunei Government, Shell, Mitsubishi)	Asia Pacific
	Papua New Guinea	N.A.	4.00	N.A.	ExxonMobil, Oil Search, Santos, MRDC, Japan PNG Petroleum	Asia Pacific
	US	North Slope (Train 1-4)	9.00	NA	Yukon Pacific	Asia Pacific
	Peru	Peru LNG	4.40	2008	Hunt Oil, SK	Us West Coast
	Bolivia	Pacific LNG	4.00	2006	Repsol-YPF, BG, BP	US West Coast
	Sub-total		73.55			
Middle East	Qatar	Qatargas (Train 4)	4.80	2005	N.A.	Europe
	Yemen	Yemen LNG (Train 1, 2)	5.30	2005	Total, Yemen Gas Corp, Hunt, SK	Asia, Europe
	Iran	LNG 1: Iran LNG	8.00	N.A.	NIOC, BP, Reliance	Asia, Europe
		LNG 2: Pars LNG	8.00	N.A.	NIOC, Total, Petronas	Asia, Europe
		LNG 3: Persian LNG	8.00	N.A.	NIOC, Shell, Repsol	Asia, Europe
		LNG 4: NIOC LNG (Train 1, 2)	9.00	2007-8	NIOC, BG, ENI	Asia, Europe
	Sub-total		43.10			
Total			**116.65**			

Source: Industry Sources

(2) Receiving terminals

As for the receiving terminals in the consumer countries, Japan currently has 25 terminals in operation and six more under construction or planned; South Korea has three terminals operating in Pyeongtaek, Inchon, and Tongyoung and another in Gwangyang due for completion in 2005; and Taiwan has one terminal operating in Yung-An and plans to construct second one in Taichung. In India, the Dahej terminal became operational in January 2004 and another in Hazira is expected on stream later the same year. In addition to these two, India has many plans for receiving terminal construction. China is constructing one in Guangdong province and is planning to build in locations including Fujian, Zhejiang, Shangdong and Shanghai. There are also LNG receiving terminal projects underway on the West Coast of the US and Mexico and the Philippines (Table 9).

Table 9 LNG receiving terminals in the Asia-Pacific region

Country	Name	Owner	Capacity (Million Tonnes/Year)	Storage (Thousand kl)	Start-up
Japan	Sendai	Gas Bureau, City of Sendai	0	80.0	1997
	Higashi Niigata	Nihonkai LNG	4	720.0	1984
	Futtsu	Tokyo Electric	7	860.0	1985
	Sodegaura	Tokyo Electric, Tokyo Gas	10	2660.0	1973
	Higashi Ogishima	Tokyo Electric	6	540.0	1984
	Ogishima	Tokyo Gas	2	600.0	1998
	Negishi	Tokyo Electric, Tokyo Gas	4	1180.0	1969
	Sodeshi	Shimizu LNG	0	177.2	1996
	Chita Kyodo	Chubu Electric, Toho Gas	0	300.0	1977
	Chita	Chita LNG	3	640.0	1983
	Chita Midorihama	Toho Gas	1	200.0	2001
	Yokkaichi LNG Center	Chubu Electric	3	320.0	1987
	Yokkaichi	Toho Gas	0	160.0	1991
	Kawagoe	Chubu Electric	4	480.0	1997
	Senboku I	Osaka Gas	1	18.0	1972
	Senboku II	Osaka Gas	8	1585.0	1977
	Himeji I	Kansai Electric	3	520.0	1979
	Hiameji II	Osaka Gas	3	560.0	1984
	Hatsukaichi	Hiroshima Gas	0	85.0	1996
	Yanai	Chugoku Electric	1	480.0	1990
	Oita	Oita LNG	3	460.0	1990
	Tobata	Kitakyushu LNG	1	480.0	1977
	Fukuoka	Saibu Gas	2	70.0	1993
	Nagasaki	Saibu Gas	0	35.0	2003
	Kagoshima	Nippon Gas	0	36.0	1996
	Sakai	Sakai LNG	3	420.0	2005
	Muzushima	Chugoku Electric, Nippon Oil	3	160.0	2006
	Wakayama	Kansai Electric	N.A.	840.0	N.A.
	Joets	Chubu Electric, Tohoku Electric	N.A.	720.0	N.A.
	Sakaide	Shikoku Electric, Cosmo Oil, Shikoku Gas	N.A.	180.0	2010
	Okinawa	Okinawa Electric	N.A.	N.A.	2014
South Korea	Pyeongtaek	KOGAS	7	1000.0	1986
	Inchon	KOGAS	7	1680.0	1996
	Tongyoung	KOGAS	3	420.0	2002
	Gwangyang	POSCO	N.A.	N.A.	2005

(Continues to the next page)

Table 9. LNG receiving terminals in the Asia-Pacific region (continued)

Country	Name	Investor	Capacity (Million Tonnes/Year)	Storage (Thousand kl)	Start-up
Taiwan	Yung An	CPC	8	690.0	1990
	Taichun	CPC	NA	NA	2008
China	Shenzhen, Gwangdo	CNOOC, BP	3	NA	2006
	Putian, Fujian	CNOOC, Fujian Investment and Development	3	N.A.	2007
	Shangdong	SINOPEC	3	N.A.	2007
	Shanghai	Shenergy	3	N.A.	N.A.
India	Dabhol	Enron, GE, Bechtel	5	N.A.	N.A.
	Dahej	Petronet	5	320.0	2004
	Cochin	Petronet	3	N.A.	2007
	Ennore	CMS, Unocal	3	N.A.	N.A.
	Pipavav	BG, SKM	3	N.A.	N.A.
	Trombay	Total, Tata, GAIL	3	N.A.	N.A.
	Hazira	Shell, Essar, Total	3	320.0	2004
	Jamnagar	Reliance, Total, Tractebel	5	N.A.	N.A.
	Gopalpur	Al-Manhal, Ipicol	5	N.A.	N.A.
	Mangalore	Finolex	3	N.A.	N.A.
	Kakinada	IOC, Petronas	3	N.A.	2006
	Vizag	Total, HPCL	3	N.A.	N.A.
Philipines	Bataan	GN Power	N.A.	N.A.	N.A.
US	Port Pelican (Off-shore), LA	ChevronTexaco	7	N.A.	2007
	Humboldt Bay, CA	Calpine	N.A.	N.A.	N.A.
	Ventura (Off-shore), CA	Crystal Energy	N.A.	N.A.	N.A.
	Ventura (Off-shore), CA	BHP Billiton	N.A.	N.A.	2008
	Long Beach, CA	Mitsubishi	N.A.	N.A.	2007
Mexico	Ensenada, Baja California	Sempra, Shell	N.A.	N.A.	2007
	Rosarito, Baja California	ChevronTexaco	N.A.	N.A.	N.A.
	Lazaro Cardenas	Tractebel	N.A.	N.A.	N.A.
	Lazaro Cardenas	Repsol YPF	3	N.A.	2008

Source: Industry Sources

4. LNG demand-Supply balance

(1) LNG demand forecast

Table 10 shows the estimated LNG demand in the Asian market, which was projected by oil company, gas company, consulting firm and research institutes. Whereas the region's total LNG demand for 2002 was 77.9 MT, the LNG demand for 2010 and 2015 is expected to total 102–129 MT and 124–171 MT respectively, of which India and China will jointly account for 7–21 MT for 2010 and 20–38 MT for 2015. The annual demand growth rate for the whole region is expected to range from 3.4% to 6.5% in the years 2002–2010 and from 3.7% to 6.2%/year in the years 2002–2015.

Table 10. LNG demand forecasts for Asian market

2010 (Million Tonnes)

	2002 Imports	Wood Mackenzie	Tokyo Gas	Shell	Energy Argus (Reference Case)	Cedigaz	Annual Growth (2002-2010)
Japan	55.0	69.1	62-71	64.0	62.5	63-65	1.1-3.2%
South Korea	17.5	2.2	24-28	23.0	26.0	23.5-25.5	2.7-6.1%
Taiwan	5.4	10.4	8-12	11.0	10.4	38,208.0	5.1-10.5%
Sub-total	77.9	81.7	94-111	98.0	98.9	94.5-99.5	2.1-4.5%
India	0.0	12.0	5-10	13.0	10.0	38,115.0	-
China	0.0	8.0	3-6	8.0	7.1	2-5.6	-
Other	0.0	-	0-2	-	-	-	-
Sub-total	0.0	20.0	8-18	21.0	17.1	7-13.6	-
Total	77.9	101.7	102-129	119.0	116.0	101.5-113.1	3.4-6.5%

2015 (Million Tonnes)

	Wood Mackenzie	Tokyo Gas	Shell	Energy Argus (Reference Case)	Cedigaz	Annual Growth (2002-2015)
Japan	73.6	67-85	N.A.	66.3	N.A.	1.4-3.4%
South Korea	24.3	27-33		30.1		2.6-5.0%
Taiwan	13.8	10-15		13.1		4.9-8.2%
Sub-total	111.7	104-133	-	109.5	-	1.9-4.2%
India	16.0	10-20	N.A.	14.0	N.A.	-
China	12.0	10-15		14.0		-
Other	-	0-3		-		-
Sub-total	28.0	20-38	-	28.0	-	-
Total	139.7	124-171	-	137.5	-	3.7-6.2%

Sources: Ministry of Finance, Korea Energy Economics Institute, TEX Report, Wood Mackenzie, Tokyo Gas, Shell, Energy Argus, Cedigaz

(2) LNG supply potential

This section refers to the LNG production capacity figures for the Asia-Pacific region and the Middle East for the year 2002 to match the latest demand data for the Asian region, not to Table 6 above that shows the figures for 2003. As shown in Table 11, the Asia-Pacific and the Middle East regions had an LNG production capacity of 87.45 MT/year at the end of 2002. Liquefaction capacity for projects under construction or with signed SPAs or HOAs in the regions totals 82.70 MT/year. Since these projects are to come in reality with high possibility, we can expect an LNG supply capacity of 170.15 MT/year around 2010. Of this capacity, 4.2 MT/year from existing projects and 50.96 MT/year from projects under construction or with signed SPAs and/or HOAs will be directed to Europe and North America. The remaining 114.99 MT/year may be considered a relatively reliable figure for LNG supply capacity for the Asia-Pacific market in 2010.

As shown by Table 8, a number of reserve studies and market surveys are conducted in the Asia-Pacific region, the Middle East and Latin America. Thus, another 116.65 MT/year may be directed to the

Asia-Pacific market. Since 22.2 MT/year of this total are to be exported to Europe or North America, the remaining 94.45 MT/year is likely to be the LNG production capacity for the Asian market.

Table 11. Progress of LNG projects in the Asia-Pacific region

	Liquefaction Capacity (Million Tonnes/Year)	
Existing		
Asia Pacific	60.75	MLNG 3 excluded. See Table 6 for details.
Middle East	26.70	
Sub-total	87.45	
For European Markets	-4.20	
For Asia Pacific Markets	83.25	
Under Construction or SPA/HOA signed		
Asia Pacific	30.10	MLNG 3 included. See Table 7 for details.
Middle East	52.60	See Table 7 for details.
Sub-total	82.70	
For European and US East Coast Markets	-50.96	24.16 MT for Europe. 26.8 MT for North America
For Asia Pacific Markets	31.74	
Planning		
Asia Pacific	73.55	See Table 8 for details.
Middle East	43.10	
Sub-total	116.65	
For European Markets	-22.20	4.87 MT for Europe. 17.4 MT for North America.
For Asia Pacific Markets	94.45	
Total Capacity for Asia Pacific	**209.44**	

Source: Industry sources

(3) LNG demand-supply balance

Based on the LNG demand forecasts and supply potential above, the demand-supply balance is outlined here for 2010 and 2015. For convenience's sake, this section refers to the highest estimated demand by relevant sources in Table 10 as "high demand case," and to the lowest one as "low demand case."

The actual demand in the year 2002 was 77.87 MT. The high-demand case value will be 129 MT for 2010 and 171 MT for 2015, while the low-demand case value will be 102 MT for 2010 and 124 MT for 2015.

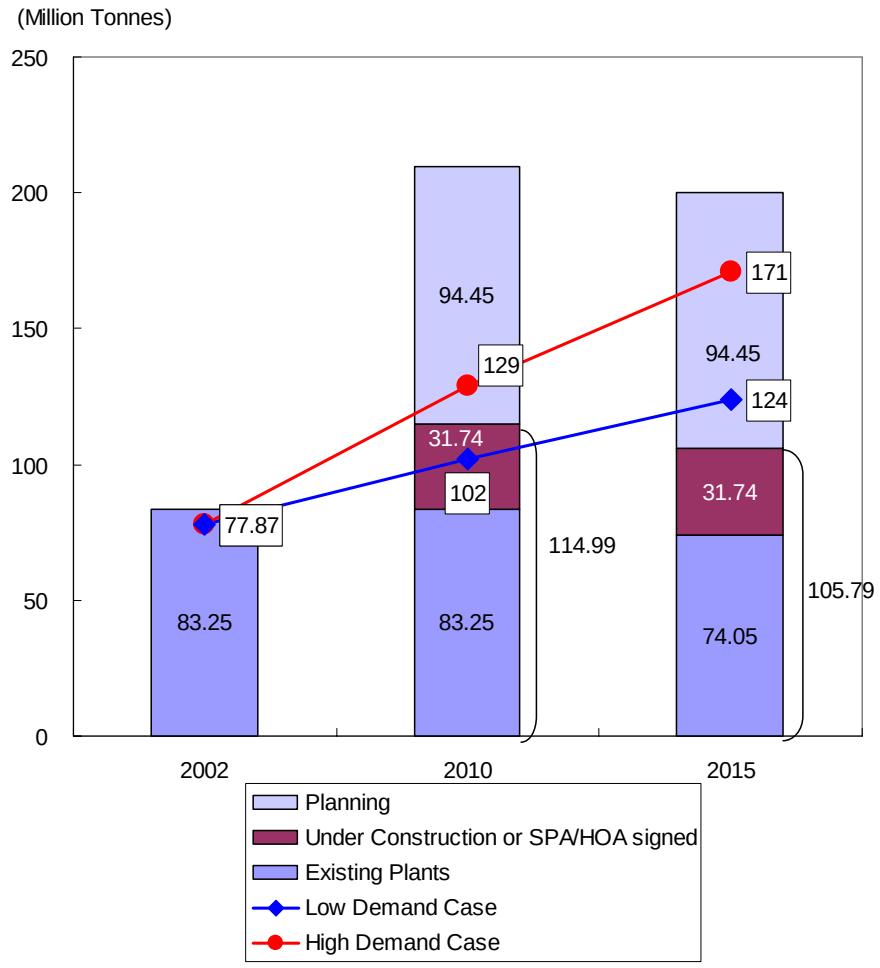
As for supply potential, the total LNG production capacity for Asia is assumed, as already seen above, to include 83.25 MT from existing projects, 31.74 MT from projects under construction or with signed SPAs or HOAs, and 94.45 MT from projects under planning. The region's total production capacity for the year 2015 excludes 9.2 MT from Indonesia's Arun and Alaska's Kenai, both of which are already showing signs of gas field reserve depletion. Moreover, the estimated total LNG supply capacities of the Asia-Pacific region for 2010 and 2015 are based on the assumption that the current contract volumes for Europe and the US will be extended and remain valid in 2010 and 2015.

In order to supply the high demand case, in addition to the existing capacities (114.99MT/year) and

capacities with signed SPAs or HOAs (105.79MT/year), it is necessary to construct production capacity of 14.01 MT by 2010 and by 65.21 MT by 2015 from projects under planning.

In the low demand case, the existing projects and those under construction or with signed SPAs or HOAs will be sufficient to meet the demand for the year 2010. As far as the demand in 2015 is concerned, however, new capacity of 18.21 MT needs to be secured from projects under planning. (Table 7)

Figure 7. LNG demand-supply balance in the Asia-Pacific region in 2010 and 2015



Sources: Ministry of Finance, Korea Energy Economics Institute, TEX Report, Wood Mackenzie, Tokyo Gas, Shell, Energy Argus, Cedigaz

Both estimated demand and supply involve uncertain factors, and the reliability is not necessarily high. In particular, it is extremely difficult to precisely predict Asia's LNG demand-supply balance for the year 2015, but at least the table above projects that the potential LNG supply capacities allocated to Asia for 2010 and 2015 will significantly exceed the estimated demand. Therefore, the current oversupply situation in the

Asian LNG market is likely to continue at least until 2010.

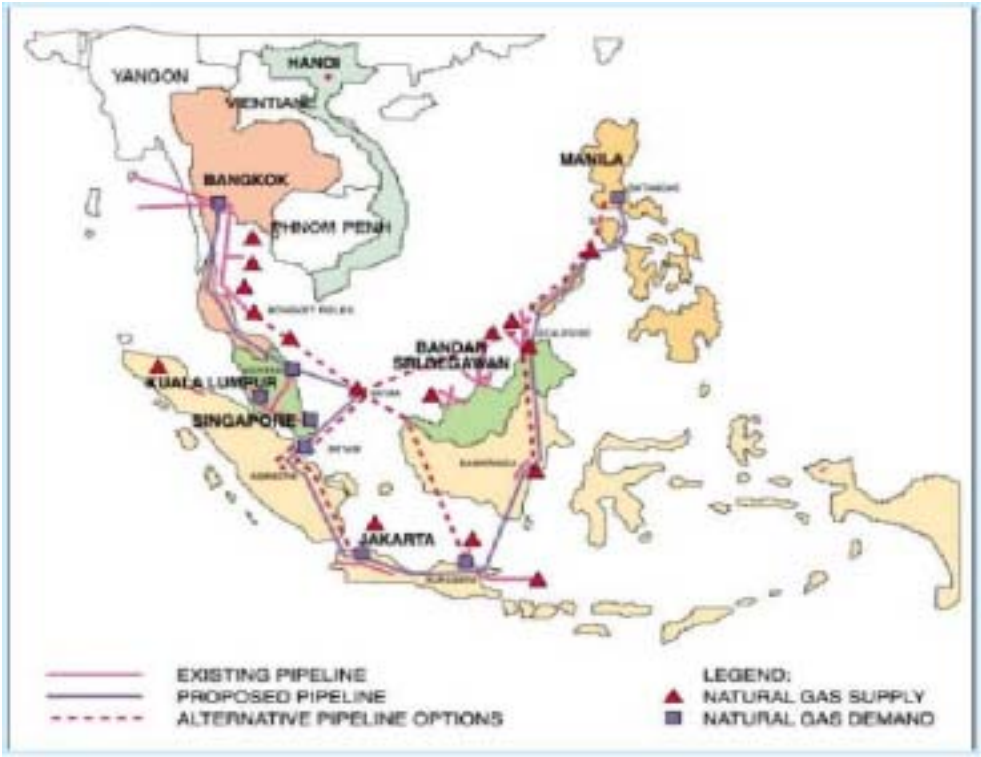
However, the LNG projects mentioned above will compete more or less with one another; therefore, it is unlikely that all of them will be implemented. Moreover, in order to realize, even partially, the potential supply capacities shown here, it will be necessary to overcome economic, political, social and ecological constraints so that each LNG developer can make investment decision. It should also be noted that the some LNG production capacities shown above might be diverted to markets outside Asia, such as the European and U.S. West and East Coast markets.

5. International gas pipelines in Asia

The Asian region has not made as much progress as Europe and North America in the construction of international gas pipelines due to the relatively long distances between the natural gas producers such as Indonesia, Malaysia, Australia and Brunei and the consumer countries such as Japan, South Korea and Taiwan that import natural gas in the form of LNG. In other words, in this region, natural gas has been supplied mainly in the form of LNG, and pipelines have had only limited use for domestic market in gas producing countries. Recently, however, a growing trend shows more Asian countries are developing international pipelines.

In Southeast Asia, pipelines connecting Malaysia with Singapore, Myanmar with Thailand, Indonesia with Singapore and Indonesia with Malaysia are already in operation. Moreover, as shown in Figure 8, there are plans to construct pipelines between Indonesia and Thailand and between Malaysia and the Philippines. These pipelines will be components of the Trans-ASEAN Pipeline Initiative. It was reported in July 2002 that energy ministers from the Southeast Asian countries signed the MOU for a gas pipeline network plan.

Figure 8. Trans ASEAN pipeline



Source: ASEAN Center for Energy

In the Middle East region, several international pipeline plans are proceeding to utilize natural gas resource in Iran and Qatar. (Figure 9 and Table 12).

Table 12. International gas pipelines under construction and supply contract signed

Route	Distance	Supply Volume
Malaysia-Thai Joint Development Area Malaysia, Thai	About 350km	4.0-8.6Bcm/y
Iran->UAE	N.A.	150-200cf/d
Iran->Kuwait	N.A.	15mmcm/d
Qatar->UAE<->Oman->(Pakistan) (Dolphin Project)	About 800km	2Bcfd
Qatar->Kuwait(Bahrain)	N.A.	1.0-1.4Bcfd

Source: Industry sources

6. Technology Developments in relation to LNG

(1) Maximizing LNG production capacity

In October 2003, it was reported that an HOA of the RasGas Project (Trains 5 and 6) was signed to export 15.6 MT/year of LNG to the US for 25 years from 2008–2009. In this project, two 7.8 MT trains are to be built. This plant would have the world's largest per-train production capacity, which is remarkably a more than 60% jump from the 4.8 MT per train of Sakhalin 2. As for the economical efficiency of upsizing liquefaction plants, there are quantitative studies available.[3]

As for liquefaction methods (process), APCI's C3-MCR method and the former Phillips' Cascade method were the only options available. Recently, however, in addition to these two methods, Linde's TMR (Triple Mixed Refrigerant) method was applied to the Snohvit Project in Norway, and Shell's DMR (Double Mixed Refrigerant) method to the Sakhalin 2 Project. Both of the two projects have proceeded to the EPC (Engineering, Procurement and Construction) phase. Neither the TMR method nor the DMR method has been applied to the construction of actual plants before. It should be noted that, unlike the conventional methods, both the TMR and the DMR methods were applied to plants sited in cold regions.

As far as feasibility studies for Iran's LNG projects are concerned, it is said France's Liquefin method (a technique developed by IFP-owned Anex) was utilized because of the US embargo on the export of US-originated technologies to Iran. If this technique is actually adopted, there will be more competition between liquefaction methods, which may lead to the greater possibility of cost reductions in the liquefaction part of the LNG chain.

(2) Offshore LNG receiving terminals

LNG receiving terminals have high energy densities. Therefore, an onshore LNG receiving terminal raises major security concerns among the local population that fear possible terrorist attacks on it. There have actually been cases of projects aborted under pressure from such NIMBY of local populations.[4]

Developers involved in receiving terminal plans have proposed different types of offshore LNG receiving terminals, including FSRUs (Floating Storage and Re-gasification Unit) or facilities converted from existing offshore facilities (platforms for depleted oil, gas or other minerals).

[3] Such as the *Oil & Gas Journal*, August 18, 2003
[4] NIMBY = Not in my backyard

Figure 10. An example of a Gravity-Based Structure that is planned by Shell in the Gulf of Mexico

Source: LNG Express, November 2003

7. Cooperation among LNG Consumers (Buyers)

There have been three reported cases of cooperation between LNG importers since 2003.

(1) LNG swap agreements among Chubu Electric Power, CPC (Chinese Petroleum Corporation) and KOGAS and between Tokyo Electric Power and KOGAS[5]

(2) Conclusion of the LNG Procurement Related Mutual Cooperation Agreement between Tohoku Electric Power and KOGAS[6]

(3) Conclusion of the LNG Swap Transaction Agreement between Chubu Electric Power and KOGAS[7]

Prior to these, there had already been reports on cooperation between gas suppliers, including the formation of GECF (Gas Exporting Countries Forum) in May 2001 and cooperation among the three Southeast Asian LNG exporters (Indonesia, Malaysia and Brunei) in June 2002. However, it is understood that there had been no reported cases of gas importers cooperation before the three cases above. These

[5] *Nikkei*, Feb. 7, 2003
[6] Press release from Tohoku Electric Power, April 18, 2003
[7] Press release from Chubu Electric Power, August 11, 2003

moves toward the formation of cooperative systems among importers within the region to cope with relatively short-term demand fluctuations are understood to help increase the actual flexibility in LNG procurement and improve supply stability for individual consumers.

Cooperation among LNG importing countries in the form of LNG accommodation is important in order to reduce inconveniences that may happen to buyers due to demand uncertainties or demand-supply imbalances under ongoing deregulation and liberalization. Here, it is important to note the existence of destination clauses included in current contracts. From the buyers' point of view, these clauses are impediments to flexible LNG transactions. If these kinds of constraints are loosened, the entire market may be stimulated, coupled with possible increases in non-conventional transactions. Such LNG swaps would enable buyers with different peak demand patterns to reduce their stockpiles and storage capacities by accommodating LNG one another. In other words, if mutual cooperation among LNG importers can absorb the fluctuation between actual demand and estimated demand, virtual stockpiling function in the region or among consumer countries may become a reality and help reduce supply security risks.

Furthermore, if looser destination restrictions give more freedom, no matter how little, to buyers (i.e., while they owe the responsibility of purchase, they can reserve the right of resale), it will become for buyers to make firm commitments to new LNG development plans, which in turn may result in further expansion of the market.

8. Atlantic LNG Market

The world's LNG market can be divided into the Asia-Pacific market, to which Japan belongs, and the Atlantic market consisting of consuming regions in Europe and the US East Coast, which import LNG from Africa, Latin America, and the Middle East. So far, the major LNG importers of Middle Eastern LNG have been in Asia, while the Atlantic market has been supplied mainly on spot or short-term contracts from the Middle East. Recently, however, that framework is beginning to change. LNG's relative competitiveness has been increasing in the US, where the gas prices are hovering due to the supply-demand crunch. This has led the US to move to conclude new LNG contracts with African countries and Trinidad and Tobago, as well as the Middle East, and to plan to build many new LNG receiving terminals. In order to cope with the increasing natural gas demand for power generation and with the concerns over the supply capacity of North Sea gas fields, which will reportedly be depleted soon, Europe has increased the number of middle- and long-term LNG import contracts with Middle Eastern and African countries. The United Kingdom, which has imported no LNG since 1990, concluded new LNG contracts and has plans to construct new receiving terminals. This section overviews the position of LNG in the US and Europe that could potentially influence the LNG supply to the Asia-Pacific region, and new LNG contracts signed by the US and the UK and their new receiving terminal construction plans.

(1) LNG in the United States

The US is the world's second largest natural gas producer after Russia, and also the world's largest natural gas consumer and importer. As of 2002, US natural gas production and consumption stood at 539.35 Bcm and 640.20 Bcm respectively. Between 1990 and 2002, US natural gas production grew at 0.6%/year and consumption at 1.3%/year. The US imports most of its natural gas via pipeline, and the figure for 2002 totaled 108.86 Bcm. In the same year, it imported 6.49 Bcm of LNG, which only covered 1% of the total natural gas consumption. Between 1990 and 2002, US pipeline gas and LNG imports increased at an annual rate of 8.5% and 8.4% respectively (Table 13 and Figure 11).

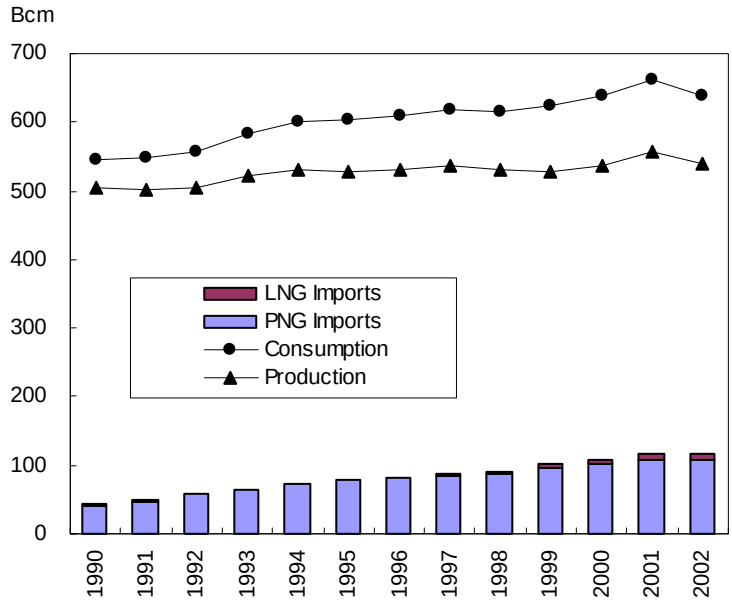
Table 13. Natural gas production, consumption, imports and exports for selected years in the US

(Bcm)

	1990	1995	2000	2001	2002	Annual Growth (1990-2002)
Production	504.85	526.66	537.62	557.16	539.35	0.6%
Consumption	545.57	602.56	639.77	662.41	640.20	1.3%
PNG Imports	40.69	79.35	102.55	109.01	108.86	8.5%
LNG Imports	2.47	0.6	6.42	6.75	6.49	8.4%
PNG Exports	1.08	2.4	5.04	8.72	12.8	22.9%

Source: Cedigaz, Natural Gas in the World

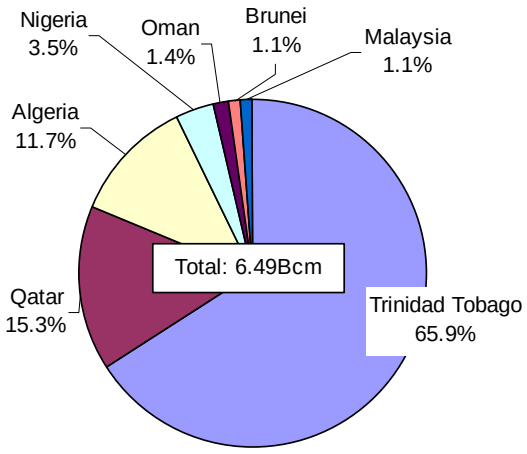
Figure 11. Natural gas production, consumption and imports in the US 1990-2002



Source: Cedigaz, Natural Gas in the World

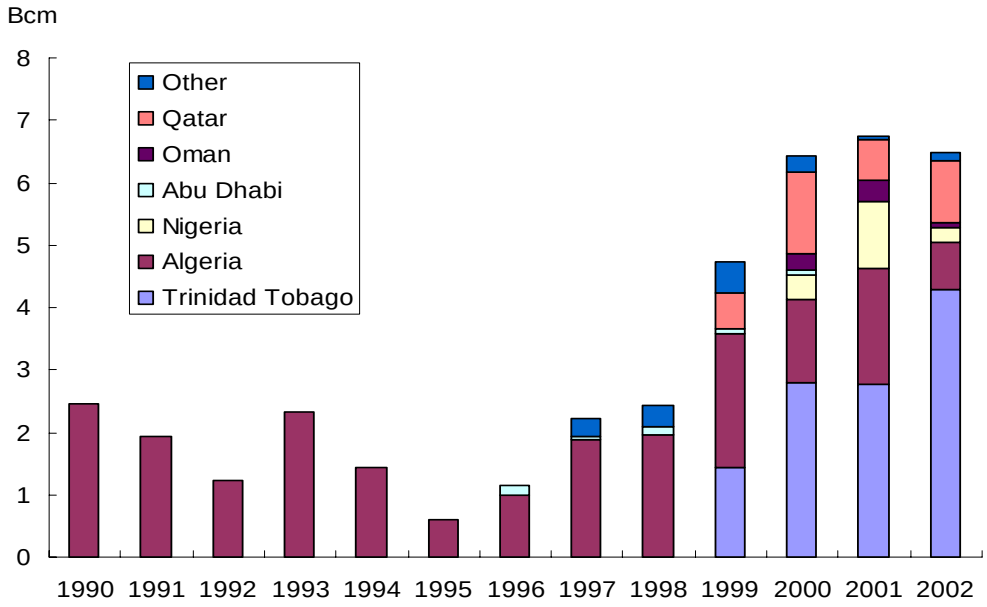
In 1990, Algeria was the only LNG supplier to the US. Since 1999, however, LNG imports from Trinidad and Tobago increased rapidly. As of 2002, the country accounted for 65.9% of the total LNG imports to the US, followed by Qatar and Algeria with 15.3% and 11.7% respectively. The US also imports LNG from Brunei and Malaysia, whose main target market is Asia (Figure 12 and 13).

Figure 12. US LNG imports by source in 2002



Source: Cedigaz, Natural Gas in the World

Figure 13. US LNG imports by source 1990-2002



Source: Cedigaz, Natural Gas in the World

(2) LNG in Europe

Europe is a large natural gas consumer next to the US, and its natural gas imports exceed that of the US.[8] In 2002, Europe produced 291.25 Bcm of natural gas and consumed 424.09 Bcm. Between 1990 and 2002, natural gas production and consumption in Europe grew at the rate of 3.1%/year and 3.2%/year respectively (Table 14 and Figure 14).

Table 14. Natural gas production, consumption and imports for selected years in Europe

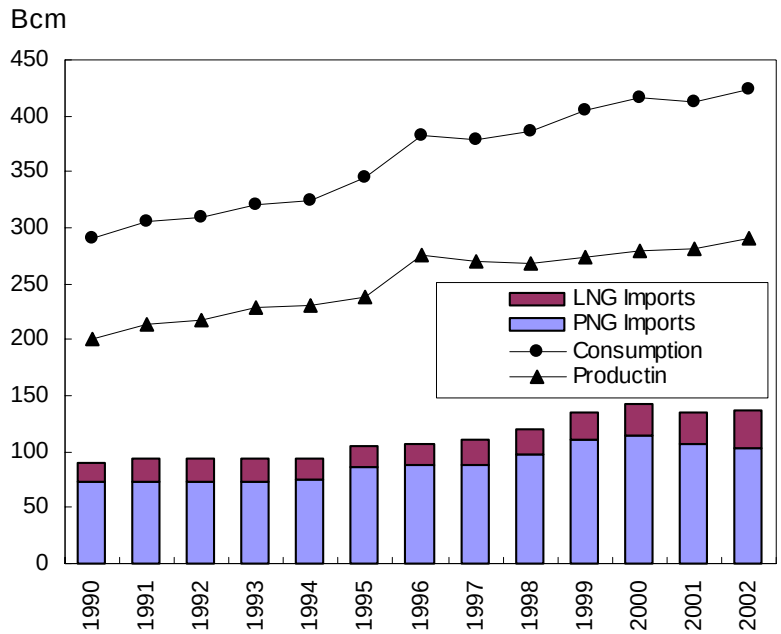
(Bcm)

	1990	1995	2000	2001	2002	Annual Growth (1990-2002)
Production	200.98	238.57	279.61	282.16	291.25	3.1%
Consumption	291.08	344.25	416.02	412.61	424.09	3.2%
PNG Imports	72.37	86.07	113.73	106.15	103.51	3.0%
LNG Imports	17.73	19.61	27.93	28.75	34.13	5.6%

Source: Cedigaz, Natural Gas in the World

[8] In this section, Europe includes 15 EU member countries (Belgium, Germany, France, Italy, Luxembourg, the Netherlands, Denmark, Ireland, the United Kingdom, Greece, Spain, Portugal, Finland, Austria, and Sweden) plus Norway and Switzerland. The imports to Europe means imports from sources outside these 17 countries.

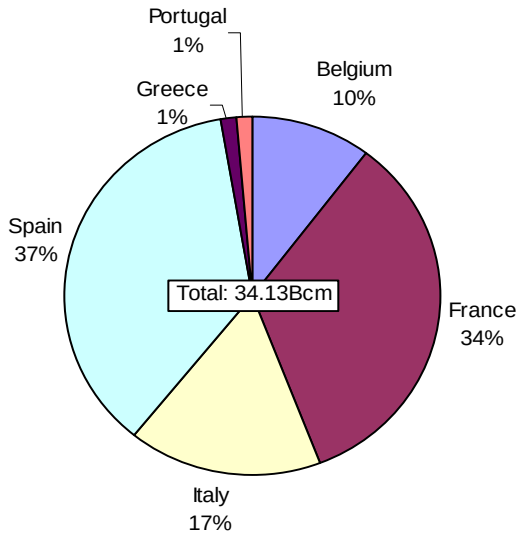
Figure 14. Natural gas production, consumption and imports in Europe 1990-2002



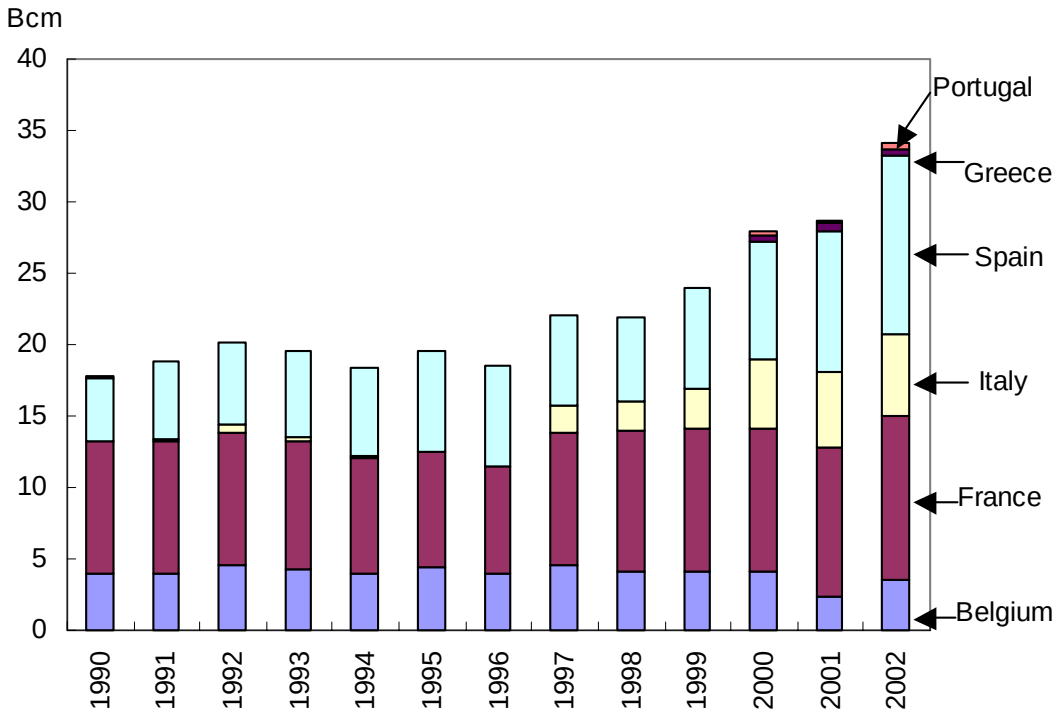
Source: Cedigaz, Natural Gas in the World

In 2002, Europe imported 103.51 Bcm of pipeline gas that is 75% of its total natural gas imports. Europe's LNG imports for the same year were 34.13 Bcm. Five countries in Europe currently import LNG: Belgium, France, Italy, Greece and Spain. Between 1990 and 2002, Europe's LNG imports increased at an annual rate of 5.6%. The national breakdown of LNG imports for 2002 reveals that Spain and France accounted for approximately 70% of the total import volume, followed by Italy and Belgium with 17% and 10% respectively. Among the existing importers, Spain has rapidly increased its LNG imports. In 2000, Greece and Portugal started to import LNG (Figure 15 and 16).

Figure 15. European LNG imports by country in 2002



Source: Cedigaz, LNG Trade and Infrastructures

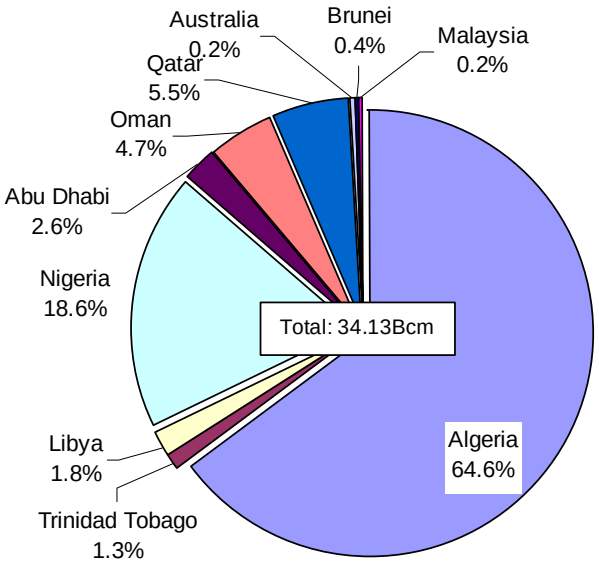


Source: Cedigaz, LNG Trade and Infrastructures

Algeria has always been the main LNG supplier to Europe. The source-by-source breakdown of LNG import for 2002 reveals that Algeria accounted for 64.6% of the total volume of 34.13 Bcm, followed by

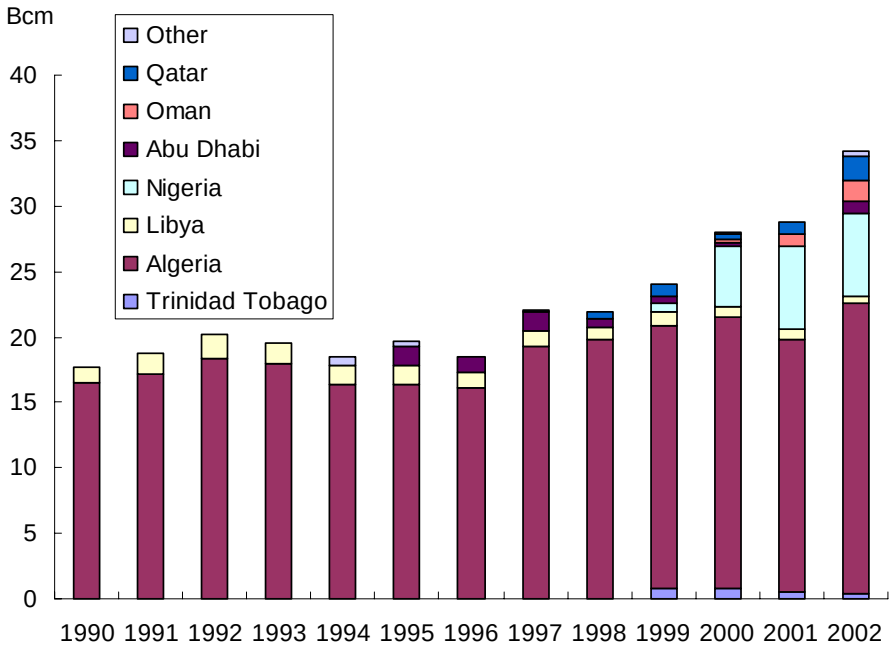
Nigeria with 18.6%, then by Middle Eastern countries (Qatar, Oman and Abu Dhabi). As with the US, Europe also imports a small amount of LNG from the Asia-Pacific region (Figure 17 and 18).

Figure 17. European LNG imports by source in 2002



Source: Cedigaz, Natural Gas in the World

Figure 18. European LNG imports by source 1990-2002



Source: Cedigaz, Natural Gas in the World

(3) New LNG Supply Contracts and Receiving Terminal Projects for the US

As explained above, LNG has only a limited role in the current US natural gas market. However, LNG's relative price competitiveness has increased because of the high domestic natural gas prices over the last several years and decreasing LNG costs. Entering 2003, the average monthly Henry Hub spot price, which serves as the benchmark for pipeline gas prices in the US, exceeded $7/MMBtu (1 million British Thermal Units) and momentarily exceeded $10/MMBtu in March. The average monthly Henry Hub spot price for January through August more than doubled from the level for the same period the last year and soared to $6.0/MMBtu.[9] There are few known cases where the Henry Hub price remained high during the low demand season that is from early spring to the end of summer. These circumstances have prompted Federal Reserve Board (FRB) Chairman Alan Greenspan to express his concerns over a possible natural gas demand-supply crunch and the impact that inflation triggered by the crunch would have on the national economy. As shown above, LNG supply to the US has expanded in recent years, and there have been many reports on new supply contracts and new receiving terminal construction plans. The following tables show new long-term LNG supply contracts for the US and new plans to construct LNG receiving terminals mainly targeted for the US market (Table 15 and 16).

[9] Hiroyuki Yamanaka, "Background of soaring gas prices in the US and its future prospects," the Institute of Energy Economics, Japan, November 2003, http://eneken.ieej.or.jp/data/pdf/758.pdf

Table 15. New LNG long-term contracts for the US

Exporting Country	Exporter	Project (Train)	Importer	Destination	Volume (MT/year)	Start-up	Contract Duration	Contract Status
Nigeria	Nigeria LNG (NNPC, Shell, Total, Agip)	NLNG (Train 4, 5)	BG	Lake Charles, LA	2.50	Jun-05	20	SPA
Nigeria	Nigeria LNG (NNPC, Shell, Total, Agip)	NLNG (Train 4, 5)	Shell	US	1.10	2005	20	SPA
Nigeria	Nigeria LNG (NNPC, Shell, Total, Agip)	NLNG (Train 6)	Total	US, Europe	0.88	2007	20	SPA
Nigeria	Nigeria LNG (NNPC, Shell, Total, Agip)	NLNG (Train 6)	Shell	US, Mexico, Europe	1.40	N.A.	20	SPA
Qatar	Ras Laffan LNG Company Limited II (QP, ExxonMobil)	RasGas (Train 5, 6)	ExxonMobil	Texas	15.60	2008-9	25	HOA
Qatar	QP, ConocoPhillips	Qatargas III (Train 1)	ConocoPhillips	Gulf of Mexico	7.50	2008-9	N.A.	HOA
Indonesia	BP, MI Berau, Nippon Oil, CNOOC, KG Berau, LNG Japan	Tangguh (Train 1, 2)	Sempra	Ensenada, Baja California, Mexico	3.70	2007	15	HOA
Indonesia	Pertamina, Expan	Sulawesi	Marathon	Tijuana, Baja California, Mexico	6.00	N.A.	20	MOU
Australia	ChevronTexaco, Shell, ExxonMobil	Gorgon (Train 1, 2)	ChevronTexaco	Rosarito, Baja California, Mexico	5.00	2008	20	MOU
Equatorial Guinea	Marathon, GEPetrol	Bioko LNG	BG	Lake Charles, LA	3.40	2007	17	LOU

Note: It is not clear if the MOU between Pertamina, Expan and Marathon to supply LNG to Baja California will result in actual LNG delivery because Marathon cancelled the plan for building receiving terminal.

Source: Industry sources

Table 16. New LNG receiving terminal plans mainly targeted for the US market

Country	Name	Investor	Capacity (MT/year)	Start-up
US	Boston, MA	Weaver's Cove Energy	N.A.	2007
	Boston, MA	Somerset LNG	N.A.	2008
	Providence, RI	BG, KeySpan	N.A.	2005
	Camden, NJ	BP	N.A.	2008
	Freeport, TX	Cheniere Energy, ConocoPhillips	380	2007
	Cameron, LA	Sempra	520	2007
	Port Pelican (Off-shore), LA	ChevronTexaco	690	2007
	Ventura (Off-shore), CA	Crystal Energy	N.A.	N.A.
	Ventura (Off-shore), CA	BHP Billiton	N.A.	2008
	Long Beach, CA	Mitsubishi	500	2007
	Mobile Bay, AL	ExxonMobil	N.A.	2008
	Sabine Pass, TX	ExxonMobil	N.A.	2008-2009
	Corpus Christi, TX	ExxonMobil	N.A.	N.A.
	Off-shore, Gulf of Mexico	McMoran Exploration	N.A.	N.A.
Mexico	Ensenada, Baja California	Shell, Sempra	690	2007
	Rosarito, Baja California	ChevronTexaco	N.A.	N.A.
Bahama	Grand Bahama Island	Tractebel	N.A.	2004
	Grand Bahama Island	AES	380	2004
Canada	St. John, New Brunswick	Irving Oil	240	2006
	Point Tupper, Nova Scotia	Access Northeast Energy	N.A.	2007

Source: Industry sources

What is important about new U.S receiving terminal projects in relation to the Asia-Pacific market is the progress in projects on the West Coast. If LNG is supplied from the Asia-Pacific region to the West Coast, import price is likely to link with gas prices in California, which will be the primary consuming region. This means that a price formula different from the current JCC (Japan Crude Cocktail)-linked price system will be introduced into the Asia-Pacific market. Moreover, LNG supply to the highly liquid US gas market will lead to formation of non-conventional forms of LNG transactions as short-term and flexible contract terms that could be favorable to the consumer. Such forms of transactions may influence the relatively inflexible form of long-term LNG transactions currently applied to the Asian market.

(4) UK's LNG Import Revival and Receiving Terminal Projects

The UK does not currently import LNG. However, the prospect of a decrease in the gas supply from the North Sea has given rise to plans to construct new receiving terminals or reopen closed terminals to resume LNG imports.

In June 2002, ExxonMobil and Qatar Petroleum signed an HOA to supply 15.6 MT of LNG to the UK annually for 25 years from 2007. The two companies will jointly construct a receiving terminal in Milford Haven. National Grid Transco, the British power grid/gas pipeline operator, will start to import 3.3 MT/year

of LNG from 2005. Meanwhile, BG, Petroplus (the Netherlands) and Petronas will jointly import 6.6 MT of LNG from 2007. If these plans are implemented, the UK will become one of the world's largest LNG importers with a total annual import of 25.5 MT/year (Table 17 and 18).

Table 17. New LNG long-term contracts to the UK

Exporting Country	Exporter	Project (Train)	Importer	Destination	Volume (MT/year)	Start-up	Contract Duration	Contract Status
Qatar	Qatar Petroleum, ExxonMobil	Qatargas II (Train 1,2)	ExxonMobil	Milford Haven	15.60	2007	25	HOA

Source: ExxonMobil press release on June 24, 2002

Table 16. New LNG receiving terminal plans for the UK

Country	Name	Investor	Capacity (MT/year)	Start-up
UK	Isle of Grain	National Grid Transco	3.30	2005
	Milford Haven	Petroplus, BG, Petronas	6.60	2007
	Milford Haven	ExxonMobil, Qatar Petroleum	15.60	2007

Source: Industry sources

(5) LNG Ministerial Summit

On December 17 and 18, 2003, the US Department of Energy invited ministers in charge of LNG production and supply from 24 countries[10] to a two-day LNG ministerial summit held in Washington D.C. It was reported that owners and builders of LNG vessels, receiving terminal owners, LNG-related facility builders, pipeline owners, buyers of natural gas and LNG and safety and security risk management authorities were invited, but the world's largest LNG importer, Japan, was not.

At the table of the summit, Spencer Abraham, the US Energy Department Secretary stated that it is unlikely that natural gas production will grow significantly in the US and Canada that have been major natural gas supply sources, and thus the US will have to depend on imported LNG to meet the growing demand. He expects that, in 2025, the US domestic gas production will meet only 75% of the demand, LNG imports will reach 13 Bcfd (Billion Cubic Feet per day), more than 20 times as much as today, and will account for 15% of total natural gas supply. Thus, Abraham claims that the US will need 9 new LNG receiving terminals in addition to the existing 4.

[10] According to the United States Energy Association, the following 24 counties were participants: Algeria, Angola, Argentina, Australia, Bahamas, Brazil, Brunei, Canada, Egypt, Equatorial Guinea, Indonesia, Italy, Mexico, Nigeria, Norway, Oman, Peru, Qatar, Russia, Saudi Arabia, Trinidad and Tobago, the UAE, the United States, and Venezuela. These countries either are existing LNG exporters or have large-scale natural gas reserves or LNG development plans (The U.S. Department of Energy, The Office of Policy and International Affairs, http://www.pi.energy.gov/lngsummit03/index.html).

Shell, as a market player, pointed out that buyer-seller trust is the foundation of LNG business and becomes particularly important when the LNG market is rapidly expanding. The company also emphasized that, despite the rapid transformation of the LNG market, long-term contracts will continue to serve as the primary means of investment in new supply sources in the coming two decades, considering that long-term contracts have been the driving force for the development of the LNG industry.

ExxonMobil claimed that a coherent policy is necessary to promote the use of natural gas and secure additional natural gas supply sources including LNG. Stressing that North America has not secured adequate natural gas supply sources to be consumed in the next six years, the company insisted that it is necessary to develop new and economically feasible supply sources that can replace the existing but diminishing ones to cover the increasing demand. Pointing out that the US needs to have additional LNG receiving terminals, the company requested that all levels of regulatory agencies, including the federal and state governments, enhance the efficiency of the authorization processes for construction of these new infrastructures.

The achievements of the summit include: the estimation of the world's LNG market growth for the next 20 years, the establishment of a consensus on the existence of structural impediments to the increase of market opportunities and a more comprehensive and transparent LNG market, and the identification of agendas to which both producers and consumers should commit themselves for the expansion of the LNG market.

As explained above, there is a new increase in LNG supply for the Atlantic. We can observe an accelerating trend to divert LNG from sources originally developed for the Asia-Pacific market, including Japan, to the Euro-American markets. Bearing in mind that Japan depends on LNG for most of its natural gas supply, we should maintain a close eye on whether the price system, and terms and conditions applied to transactions there,[11] are convincingly coherent and reasonable when compared with those applied to Japan.

9. Noteworthy Trends in Japan

After 30-odd years since the establishment of the Japanese LNG market in 1969, many of the early contracts have been renewed one after another since 2000. Most LNG buyers in Japan are power and gas companies that are affected by ongoing liberalization and deregulation. Under these circumstances, there are several new moves emerging. On the sellers' side, nowadays, there are a number of projects that are said to be ready as soon as demand is confirmed. This is another sign of the intensification of competition.

(1) Changes in the Traditional Contract Conditions

We will outline recent changes in LNG contracts for Japan, mainly concerning terms and conditions

[11] Akiyuki Fujita, Takeharu Ueda, Shinya Nagasaka and Satoshi Sano, "Current Situation and Future Prospects of Japanese LNG Market" the Institute of Energy Economics, Japan, October 2002, http://eneken.ieej.or.jp/en/data/pdf/171.PDF

normally included in traditional long-terms contracts.

1) Contracting Parties

It has been a tradition among Japanese buyers that power and gas companies jointly form buyers' consortium to negotiate the terms and conditions of contracts equally applied to individual buyers. However, recent differences of interests between individual buyers have induced. Therefore, some buyers are opting to negotiate and conclude contracts independently of other buyers. Meanwhile, there are still buyers that prefer to maintain buyers' consortium in order to exert stronger bargaining power, which derives from bulk purchases, during negotiations with sellers. There are also cases where gas companies formed consortium of their own.

2) Contract Periods

Currently, it has become impossible to expect steady gas demand growth in Japanese market, and the progress of liberalization could lead to a partial loss in demand for each LNG importer. It is difficult to commit fixed long-term demand volumes. Therefore, the preference is to incorporate shorter-term elements into long-term contracts.

3) Quantity Tolerance

With liberalization in progress, there is a growing demand for a wider quantity tolerance that would allow the difference between actual demand and contracted volume. It is said that this trend reflects buyer needs for a bi-directional expansion of the tolerance. Buyers are demanding more tolerance within which they are not held responsible by the acceptance conditions based on the take-or-pay clause, especially when a partial cancellation occurs (downward tolerance). On the other hand, upward quantity tolerance is increasingly important in some cases, depending on importers and/or exporters situation.

4) Delivery Terms

In order to reduce LNG procurement costs, some importers have started to have their own transportation vessels or to procure the means of transportation on their own initiative. This is a transition from ex-ship transactions, where the seller is responsible for transportation, to FOB (free on board) transactions, for which the buyer assumes the responsibility for transportation. Having transportation capabilities enables importers to exercise other trading options, including spot swap, backhauling and arbitrage transactions.

5) Delivery Scheduling

Traditionally, the general rule in terms of LNG delivery has been that vessels are scheduled at regular intervals throughout the year, disregarding seasonal fluctuations in gas demand. These days, there are cases of irregular delivery intervals that allow importers to adjust their seasonal demand fluctuations more precisely.

Moreover, as a new form of transaction in recent years, some exporters proposed the "master agreement

system"[12] to LNG importers in Japan, and it was reported that some importers agreed to the proposal. The master agreement system is a specific set of conditions prearranged to exercise spot transactions more easily. A master agreement would include general terms and conditions. At the stage of actual spot transaction, detailed condition such as price, volume and delivery timing would be decided. This was developed as another means of timely procurement under random changes in demand to cope with difficulties in reasonably predicting demand—a form of transaction that matches the recent transformation of the market.

(2) Stability of LNG Supply

The year 2003 was studded with problems on the part of LNG suppliers, including liquefaction facility difficulties. In August 2003, a Malaysian plant had to stop operation for eight-month long repairs because of a fire in the brand new seventh train (Tiga), which had just reached completion.

Though not immediately relevant to the Asia-Pacific market, there was a boiler explosion in the Skikda liquefaction complex in Algeria in January 2004, and three of its six trains stopped operation. Being an exporter of both LNG and pipeline gas, Algeria managed to minimize the influence of the accident by increasing exports of the latter. There does not seem to be any tangible influence on the Asia-Pacific market. However, there still remains the possibility that the accident may affect the Asia-Pacific market, if a supply-demand crunch occurs in the Atlantic market and induces a surge in spot supply transactions between the Middle East and the Euro-American market.

Indonesia had to import LNG cargoes from the Middle Eastern and other countries to fulfill its supply contract because of depleting Arun gas field and troubles at Bontang gas field.

Fortunately, these three cases did not lead to interruption of supply, but they highlighted the fragility inherent in LNG supply. Built back in the 1970s and 1980s, once-advanced facilities in Southeast Asia are already 20 to 30 years old and are likely to experience problems from age-related deterioration. Therefore, it may be necessary on the part of buyers to raise awareness for unprecedented, yet possible, contingencies on the supplier side such as those mentioned above.

(3) Entering Upstream in the LNG Value Chain

The LNG value chain consists of natural gas development and production, liquefaction, transportation, receiving and degasifying and finally to distribution. Traditionally, LNG buyers in Japan, namely power companies and gas companies, have only been committed to receiving terminals, regasification and distribution based on ex-ship contracts.

Recently, however, buyers are beginning to own or arrange LNG vessels for their side[13] in order to switch the terms of delivery from ex-ship to FOB. Risks involved in transportation, which is the midstream section

[12] *Denki Shimbun*, Dec. 4, 2003, and TEX report, February 19, 2004
[13] Press release from Osaka Gas, Oct. 27, 2000, and that of Tokyo Gas, October 2, 2003

of the value chain, are considered relatively small compared with upstream investment risks involved in exploration and mining. It is also thought that self-procurement of transportation will contribute to cost reductions to a significant extent.[14] Considering the advantages of having an immediate means for diversified transaction forms, including spot and swap deals, which could become common (these forms of transactions have great potential for facilitating procurement to suit demand), buyers' expansion into the LNG transportation business should be understood as meaningful and effective.

Moreover, some buyers have gone further than the LNG transportation business. They have become directly involved in the development of natural gas and LNG production, achieving a full-commitment to the entire LNG chain from gas production, liquefaction, sales, and transportation to consumption for power generation or gas businesses. Thus, they are involved in the upstream development and production as contributors to stable and economical procurement of fuels and materials.[15] These moves can be viewed as efforts to achieve a *best cost-profit balance* through commitment to the entire value chain, identification of the cost elements involved, and understanding of the chain's entire structure.

One of the major concerns for each LNG importer over the progress of liberalization and deregulation is the possibility that competition may cause random fluctuations in demand. With an awareness of stepwise increases and decreases in demand due to the acquisition and loss of high-volume customers, the terms and conditions of procurement contracts are becoming less stringent and more flexible in terms of delivery volume and contract period in order to make it easier to cope with such fluctuations. In particular, the Asia-Pacific region has become a buyer's market because of the recent supply surplus. This seems likely to provide favorable conditions for buyers to persuade sellers to accept their demands regarding the terms and conditions described above that allow wider degrees of freedom and flexibility in LNG transactions.

On the other hand, some of the existing exporters were forced to take unconventional measures in order to honor the take-or-pay clause as sellers (as in the case of Indonesia in Section 10 (2) above). Usually, it is difficult for individual suppliers to deal with a sudden demand-supply fluctuation unless they have a considerable surplus capacity. Therefore, it seems reasonable that regional suppliers and consumers establish and develop a framework for better matching for LNG demand-supply, in addition to the existing buyers' cooperation mechanisms explained in Section 8.[16]

Buyers pursue both flexible and economical LNG procurement. It has been pointed out that the Asia-Pacific LNG market has a supply capacity amply exceeding demand, which in turn is pushing down regional LNG prices.[17] However, because of the difficulty in achieving such a balance, it is hardly

[14] See, for example, TEX report, February 19, 2004.
[15] Joint press release from Tokyo Gas and Tokyo Electric Power, June 30, 2003
[16] Takeo Suzuki, Takeharu Ueda, Satoshi Sano and Shinya Nagasaka, "Current Issues in the Japanese LNG Market -Relation with Gas Producers and Consumers," the 22nd World Gas Conference Tokyo 2003, June 2003, http://eneken.ieej.or.jp/en/data/pdf/199.pdf
[17] Koji Morita, "LNG: Falling Prices and Increasing Flexibility of Supply-Risk Redistribution Creates Contract Diversity", the Institute of Energy Economics, Japan, February. 2003, http://eneken.ieej.or.jp/en/data/pdf/185.pdf

imaginable that sellers would accept such a scenario. It should also be noted that the relationship between the flexibility and economics in LNG procurement has an aspect of a trade-off. In the future, it is expected that LNG buyers different from the existing power companies and gas companies will emerge and bring about changes to the market system and forms of transactions. It is desired that the Asia-Pacific LNG market will see less confrontation and more cooperation between sellers and buyers and develop under a better situation, keeping the Atlantic market's developments in view.

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